Impact of Differentiated Learning Contracts

An Action Research Project Examining the Impact of Learning Contracts using Differentiation of Product by Learning Style on A+ TestPrep Scores

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Chapter One

In 1983, a consortium of the largest worldwide computer-related businesses created the Computer and Technology Industries of America, or **CompTIA**. CompTIA's primary objective: to develop vendor-neutral information technology certifications to validate the competency of entry-level examinees.

Developing Vendor-Neutral IT Certification Exams

> CompTIA also serves the IT industry as the world's largest developer of vendor-neutral IT certification exams. Experts and industry leaders from the public and private sectors, including training, academia, and government work with CompTIA to develop broad-based, foundational exams that validate an individual's IT skill set. This group of experts provides the resources and subject matter expertise necessary to build a vendor-neutral industry-defined exam. To date, more than 600,000 people worldwide have received a CompTIA certification. (2005)
>
> *http://www.comptia.org/default.aspx*

CompTIA devised an assessment tool which uses criterion measures to certify a minimal amount of knowledge needed by an entry-level PC technician. The assessment is the "A+ Certification Exam." The exam has two parts, each focusing on a specific set of technical objectives. A+ Core assesses the depth of a candidate's hardware knowledge and A+ OS tests the candidate's operational knowledge of different computer operating systems.

During the two-year Computer Systems Technology program at Heritage High School, students may attempt the CompTIA A+ certification exams. It is necessary that the high school program increase the number of Computer Systems Technology students that pass the A+ certification exam. The call for a state-mandated certification for every graduate of the Computer Systems Technology program is gaining strength within the Virginia Department of Education. The request for an increased number of certified graduates is a response to legislators' desires to hold teachers to a higher level of

accountability, as implied in the No Child Left Behind Act of 2001. For Computer Systems Technology students across the state, this is a necessary step in improving their employability and credibility upon graduation. Information Technology and related fields create a demanding, dynamic environment that requires its participants to be adaptive, technically proficient, and committed to life-long learning. The Computer Systems Technology students receive encouragement to adopt that attitude as a component for future success.

Unfortunately, problematic issues include student access to available technology, the low scores in the A+ TestPrep exam simulations, and the reduction of the number of attempts by Computer Systems Technology students to take the CompTIA A+ Certification Exam.

The Problem

The purpose of this research project is to assess the effectiveness of differentiated learning contracts on the A+ TestPrep exam simulator.

TestOut, Inc created the A+ TestPrep exam simulator as an aid in studying for the A+ certification exams. TestPrep software is a summative assessment and measures an examinees' readiness to pass the actual A+ certification exam. The software creates an A+ exam simulated environment (timed, linear, question number, visual format) for the student. The software produces test questions from a test bank of 1550 A+ objective-based questions and electronically simulates the A+ exam. The TestPrep test software interface has the same visual format and operational feel as the actual A+ exams. Familiarity with the TestPrep may reduce test anxiety in students when attempting the actual A+ exam.

As an added note, the researcher has noticed the motivation of the students to participate in whole group lecture is decreasing. Vocal and physical resistance to direct instruction is increasing. This standardized technique of instruction reveals the frustration level of learners who vary in learning style from direct instruction. The research project will use learning contracts as a means to individualize instruction to better meet the diverse educational needs and accent the talents and abilities of the students within the classroom.

The chart on the following page shows the relationship between the year of the class, number of examinees taking the exam, and the number of students passing the A+ certification exam. The decreasing number of passing examinees may be a reflection of using out-of-date textbook. In 2003, CompTIA changed the A+ exams to reflect the advances in computer technology. The textbook used in the CST class was immediately outdated. For the 2005-2006 school year, CST will implement new textbooks in class and new A+ TestPrep software with the 2003 objectives. While having access to the newest data and A+ objectives improves the instructor's confidence that he is teaching the correct content, the student's TestPrep simulation scores have not increased as the instructor expected.

Computer Systems Technology Year-by-Year Passing Rates For A+ Certifications			
Year	Examinees	Passing	% passing
1999-2000	25	17	68%
2000-01	18	12	67%
2001-02	3	3	100%
2002-03	12	3	25%
2003-04	15	4	27%
2004-05	10	1	10%

The table on the following page shows the relationship between the A+ TestPrep exam simulation scores and the passing rates of examinees since introducing the A+ TestPrep exam simulator as a formative assessment tool. Students averaging 90 or above on the A+ TestPrep exam simulation show a 100% passing rate on the actual A+ certification exam. The table reveals that elevated performance on the A+ TestPrep exam simulator is an indicator of a potential passing score on the actual A+ certification exam. Recent classroom averages of A+ TestPrep exam simulation scores exhibit a decreasing trend. A possible cause of the current trend in lower scores is outside or external control limits of the classroom computers. The restrictions placed on computer operation and

usage by the school's administrative IT personnel may contribute adversely to the impact on the learning environment. The restrictions forbid the investigation of the computer's operating system and greatly limit the interaction of the students with the computers. Students cannot attempt numerous mandatory competencies through this investigative activity due to these limitations with the computer.

Computer Systems Technology Year-by-Year Passing Rates For A+ Certifications			
Year	Number of Examinees	Mean A+ TestPrep Scores	Percent Passing A+ Certification
1999-2000	24	93.4	100%
2000-01	12	91.3	100%
2001-02	3	92.4	100%
2002-03	3	90.8	100%
2003-04	4	91.6	100%
2004-05	1	92.1	100%

Definition of Terms

CompTIA- Computer and Technology Industries of America- an organization that develops vendor-neutral certifications for the IT industry

A+ Core Exam- the set of hardware related objectives compiled by CompTIA as a baseline for entry-level technicians into the workforce

A+ OS Exam- the set of operating systems related objectives compiled by CompTIA as a baseline for entry-level technicians into the workforce

Computer Systems Technology- the class and curriculum in which the study takes place

A+ TestPrep Exam Simulator- software used to assess student readiness for the A+ Certification Exam

LabSim OS- software used to train and prepare students to understand the objectives of the operating systems section of the A+ Certification Exam

LabSim Core- software used to train and prepare students to understand the objectives of the hardware section of the A+ Certification Exam

Constructivism- the cognitive methodology of teaching where learning is from engagement with the subject and students build their knowledge as an active learner

Information Technology- the field of work or study that relates to the use or impact of computers on the human race

Learning Contracts – is an agreement between a student and instructor to acquire knowledge systematically either in the classroom or independently. It specifies what is to be learned, how it is to be learned, and how learning will be verified.

CBT – Computer Based Training, usually relating to software used in the classroom

Triarchic Theory of Intelligence – The Triarchic Theory of Intelligence was formulated by Robert J. Sternberg, a prominent figure in the research of human intelligence. The theory by itself was groundbreaking in that it was among the first to go against the psychometric approach to intelligence and take a more cognitive approach. Sternberg's definition of intelligence is "*(a) mental activity directed toward purposive adaptation to, selection and shaping of, real-world environments relevant to one's life*" (Sternberg, 1985, p. 45), which means that intelligence is how well an individual deals with environmental changes throughout their lifespan. Sternberg's theory is comprised of three parts: componential, experiential, and practical.

Delimitations

The restrictions of the study are as follows:

- The population of the study and how it is determined.
- It was be conducted on the all the members of the Computer Systems Technology junior-level program.
- Interest level in the curriculum will be decided by the students registering for my class as an elective course
- The chance exists that a student will have low interest an performance because of being forced into the program versus choosing the program of his or her on volition.
- The population ratio of males to females and learner readiness are randomly determined.
- The software and equipment used will be determined by the instructor
- The learning styles of the students are assigned by their scores on the *Triarchic Theory of Intelligences* assessment
- The LCS IT department restrictions placed on the computers

Chapter 2
Research

Computer Systems Technology program is a mixture of direct instruction and computer-based training (CBT) curricula. This format creates a dynamic teaching environment that can be difficult to maintain and manage with a heterogeneous classroom. Students with varying learning styles may feel that their individual learning needs are not fulfilled. By implementing learning contracts that apply differentiation of product by learning style, the researcher will measure any change in student performance on the A+ TestPrep exam simulator.

The Computer Systems Technology instructor conducted an action research project that utilized the learning styles of the students. These styles of learning are based on the Triarchic Theory of Intelligence created by Robert Sternberg. According to the Triarchic theory (Sternberg, 1985), human intelligence compromises three main aspects: analytical, creative, and practical. Infused into instruction and assessment, analytical tasks involve analyzing, judging, evaluating, comparing and contrasting, and critiquing; creative tasks involve creating, inventing, discovering, imagining, and supposing; and practical tasks involve implementing, using, applying, and seeking relevance (Sternberg, 1994a, 1994b).

Other studies have produced evidence that support using Triarchic Intelligences in teaching students. Students in two studies who received Triarchic instruction generally learned more than did students who received either traditional memory-based or analytical based instruction. Greater learning was shown for a variety of kinds of assessments; including both memory-based ones were already in use and performance-

based ones that were designed especially for this project. The two experiments reported here thus suggest that students benefit from Triarchic instruction, not only if it is matched to their pattern of strengths (Sternberg et al., 1996)

Contexts for educational content can match the personal, social, and environmental dimensions of the life space of an individual (Dabbagh, 1996). Theodore Sizer (1992) reminds us that while it may be inconvenient that students differ, it is an irrefutable fact of life in the classroom (Tomlinson and Strickland, 2005). Assessing the students for their learning preferences and interests allows the instructor to create learning plans with differentiated strategies. Meeting a student's individual needs as a learner usually increases effort and engagement.

Contract learning is an alternative way of structuring a learning experience. It replaces a content plan with a process plan (Knowles, 1986). According to Knowles (1980), contract learning solves, or at least reduces, the problem of dealing with wide differences within any group of adult learners. The age of students in CST range between sixteen and nineteen years of age. One student has joined the armed forces and experienced basic military training. The young adult ages of CST supports the use of learning contracts in the classroom.

According to Frymier (1965), "Allowing students to decide which grade they wish to strive for, which activities they will engage in, and how they will demonstrate that they have satisfactorily completed their studies permits a teacher to seize upon powerful motivating forces within individual students. No one has to try for an "A." Likewise, anyone can try. This notion shifts responsibility for learning from the teacher to the student, but at the same time offers an incentive by insuring success under know

conditions. Students are challenged without being threatened. Students are almost never dissatisfied with earned grades, whatever the outcome may be" (pp. 263, 264).

Research conducted by Land and Hannafin (1996), suggests that advancement in technology has enabled the development of a range of learning environments. The use of these varied "environments" in the Computer Systems Technology program may allow learners to be more successful. Assigning contracts to students according to their learning style so that they produce the required evidence of learning is differentiation of product by learning style.

Many educators suggest that learning can be enhanced if the learning environment includes more interactive, student-centered, and engaging activities where learners construct their understanding rather than more traditional methods of teacher-centered, direct instruction (J. Blocher, S. de Montes, G. Tucker, E.M. Willis, 2000). This "constructivist" approach to teaching using learning contracts deserves further research to explore applicability in the Computer Systems Technology classroom.

Two factors support the justification for using learning contracts, as opposed to other methods of differentiation. First, the assessments administered to the students revealed the learning styles of the students varied in the heterogeneous classroom yet shared common traits. Secondly, the versatility and flexibility of differentiated learning contracts help create a learning scheme that can fit each student. Using differentiation of product by learning style allows the student to show evidence of learning through his or her dominant learning style.

Due to the ethnographic topography, informal surveys, and researcher familiarity, the following environment exists in the classroom.

- All students learn differently.
- Students with extensively varying motivations and interests exist.
- A culturally diverse group of learners exists.
- The educational needs of the curriculum need to connect to the educational needs of each individual student.

According to Caffarella (1983), learning contracts can:

1. Provide a means of dealing with the wide differences among any group of learners.
2. Enhance individual motivation for learning.
3. Facilitate the development of mutual respect between the instructor and participants.
4. Provide for a more individualizing instructional mode.
5. Foster the skills of self-directed learning.

By the differentiation of product by learning style, the student's learning contract assignment reflects his dominant Triarchic Intelligence score. Each style of contract is specifically designed to direct the way a student will ascertain knowledge, use the knowledge gained and show evidence of learning. The products of each style of contract reflect the learning style or preference of the student.

Thompson and Poppen (1972, P.188) propose that contract grading allows the instructor to incorporate a number of learning principles into grade contracts. They

suggest that the following principles are manifested through contract grading (Newcomb & Warmbrod, 1974, p.3):

1. The learner has both choice and voice in selecting alternatives for meeting learning objectives (the learner is more apt to become totally involved in a project which he or she has helped select and plan);
2. The learner is given opportunities to exercise responsibility through making commitments to complete personal learning goals;
3. Personal involvement in learning is stresses through individualized and independent learning activities;
4. The teacher refrains from giving excessive directions (too much direction from the teacher usually results in apathetic conformity, defiance, scapegoating, or withdrawal);
5. The differential learning styles of students are considered in providing alternatives to learning;
6. Competition with self is stressed over competition with others, and cooperation with others becomes an acceptable peer learning activity;
7. The learner feels a sense of freedom from the threat of failure;
8. The learning task falls within the learner's range of challenge – that area where the task is neither too easy nor too difficult and the probability for success is good, but not certain;
9. There are opportunities for novel and stimulation learning experiences;
10. At least some of the purposes, objectives, and expectations of the course are defined in behavioral terms that clarify the learning task;

11. Progress is learning depends to a considerable extent on how the learner perceives (through reinforcement or encouragement) the appropriateness of his or her efforts to accomplish the learning objectives, rewarded behaviors are naturally more likely to be repeated;

12. The learner receives feedback on the appropriateness of his or her efforts through the facility he has gained in self-evaluation;

13. Learning is generalized to other life situations (generalization is most likely to occur when the learner has achieved the intrinsic reward of feeling a sense of self-satisfaction in achieving his or her objectives).

HTTP://WWW.MSU.EDU/USER/CODDEJOS/CONTRACT.HTM

There will be improvement in the A+ TestPrep exam simulator scores when learning contracts differentiated by product using learning styles that address the student's individual learning style are implemented.

When learning contracts differentiated by product using learning styles that address the student's learning style are implemented in the classroom, there will be no improvement in the A+ TestPrep exam simulator scores.

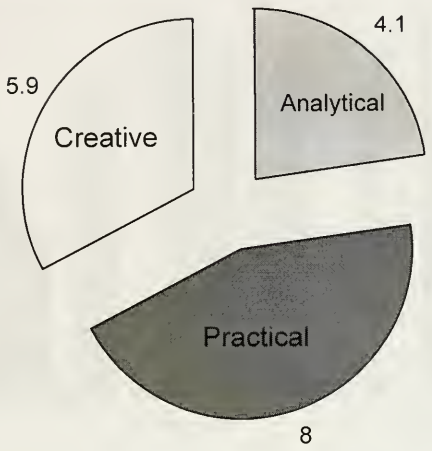
Chapter 3
Method

This action research project will access any change in the A+ TestPrep Exam Simulator scores after the implementation of differentiated learning contracts that use differentiation of product by learning style.

The instructor developed a learning profile of each student using the *Theory of Triarchic Intelligences* (Sternberg) and the *Survey of Learning Preferences Inventory* (Sternberg). This learning profile guided the instructor and student in the creation of the learning contract.

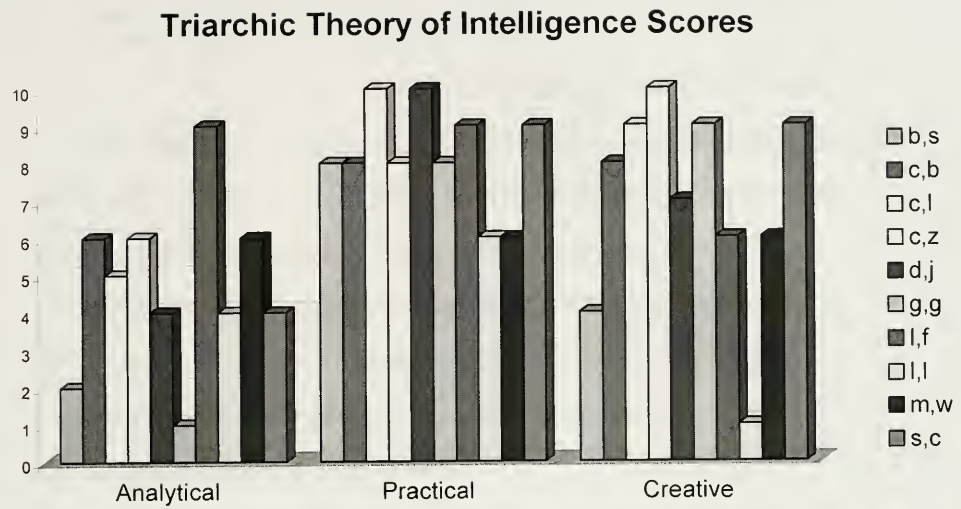
The Theory of Triarchic Intelligences (Sternberg) assessment is designed to assess the varying levels of analytical, practical, and creative intelligences a student may possess or display. The Survey of Learning Preferences Inventory (Sternberg) assesses students learning style preference. Though informative about how the student may prefer to learn, it does not imply the student will learn more using their learning preference. Before designing the contracts, the instructor will share this evidence with the student.

The analysis of the ten students assessed revealed that the average score of students who preferred **Analytical, Practical,** or **Creative** learning styles were as follows:



The average score on the Practical learning preference was 8. The average score on Creative was 5.9. The average score for Analytical was 4.1.

The chart on the following page is the results of the *Triarchic Theory of Intelligences Chart* assessment for CST1. Using two learning style assessments allow the researcher to have two scores to average, thus increasing the reliability of the assessment.



In both learning style surveys, the **practical** learning preference was predominate, in reference to the other styles of learning. **Creative** placed second and **Analytical** placed third.

For the purpose of this action research project, this data supports the researcher's choice of learning contracts for the treatment. The analysis of the students shows wide variations in the students learning styles. Due to the flexibility, individualization of learning goals, and the level of student involvement that learning contracts offer, the differentiation strategy of learning contracts accommodates the student variation of learning styles within the design of the contract.

In defining learning contracts, there are many variations but most definitions include the following:

> "Learning contracts connect educational needs to individual student needs and are useful when there is diversity in learner needs and interests in a class. A learning contract is a formal agreement written by a learner which details what will be learned, how the

learning will be accomplished, the period of time involved, and the specific evaluation criteria to be used in judging the completion of the learning. Learning contracts help the educator and learner share the responsibility for learning."

http://teachers.teach-nology.com/web_tools/contract/

This "treatment" or learning contract design connects the classroom activities to the real-world application of responsibility, interpersonal communication, knowledge advancement, skill advancement, time management, and organizational skills.

These scores are a "snapshot" assessment of the students in CST1 and will not label or limit any student with a fixed category or style. These scores reflect the possibility that a student may prefer to think or learn in certain modes. This is the practical contract assigned to seven students.

Practical Contract (2 weeks) Chapters 12,13,14,18

- Using the combinations of the textbook, PPT's, approved websites, lab manual, and other instructor-approved sources, do the following:
    - Install each OS (Win98SE, WinNT, Win 2000) precisely according to the "Installation Instructions" handout, on a hard drive and install it in a workstation. Obtain workstations from storage areas. Load all necessary drivers. Plan your file system usage wisely
        - In all the OS's, create a user account and password for all students in the CST1. 5 names must be "administrator" and the remainder will be "limited" accounts.
        - Use MMC to create a console named "preventive maintenance" in Win 2000 that matches the screenshot provided. Save the console in the default location.
    - Acquire cabling for the job from current supply
    - Use the OS hard drives created in the contract to implement a networking solution to have all 3 OS share data across the network. You must decide the data to be shared. Music, Games (AOE), etc.
        - Install TCIP/IP, NetBEUI protocols on all machines
        - Install file sharing and printing on all systems
        - Run Defrag, scandisk, disk cleanup
    - Use the project as a basis for an instruction manual for someone to repeat the same project in the future. The manual can be in Word or PPT.
- Evaluation of the contract will be determined by:
    - Activities and products assessed by instructor (checked off)

- Demonstration of the completed network, functioning correctly according to the rubric
- The quality and accuracy of the journal created according to the rubric.

The contract is designed for the student to apply, construct, and implement the knowledge gained using the skills taught in the classroom. Improving or unifying conceptual skills into physical action is the core of the design.

Below is the creative contract that was assigned to two students.

Creative Contract- 2 weeks Chapters 12,13,14,18

- Read each chapter summary independently in the class.
- Using the combinations of the textbook, PPT's, approved websites, lab manual, and other instructor-approved sources, do the following:
  - Create a demonstration in class, outlining the architecture, installation process, and troubleshooting guidelines of each OS (Win98SE, WinNT, Win 2000) with a PPT, handouts of step-by-step instructions
  - Installation - demo, PPT, step-by-step handout
  - Architecture – 1 handout explaining each OS architecture
  - Troubleshooting – Follow a supplied step-by-step flowchart and fix a problem created by YOU. You think it, create it, and then show the class how to fix it.
- Use the project as a basis for an instruction manual for someone to repeat the same project in the future. The manual can be in Word or PPT and preserved in a 3 ring binder with sheet protectors.
- The cover of the manual must be uniquely designed and attractive to the teenage audience
- Create a hip-hop or equivalent voiceover to correspond to the Instruction manual. No profanity or words in bad taste.

The creative contract is designed for the student to create, construct, and implement the knowledge gained using the skills taught in the classroom. Using creativity in the design of installation manuals and in the demonstration of conceptual skills is the core of the design.

The analytical contract utilized the students' ability to judge and analyze the operating systems being studied and the methods of the students building the actual network. Analysis and evaluation to skill standards are the basis of the contract. Only one student was assigned this style of contract.

Analytical Contract- 2 weeks Chapters, 12, 13, 14, 18

- Using the combinations of the textbook, PPT's, approved websites, lab manual, and other instructor-approved sources, do the following:
- Analyze each of the OS s' (Win98SE, WinNT, Win 2000) and create a comparison guide using Excel worksheet. It will be printed. Consider the following.
    - All minimum requirements
    - How hardware is managed.
    - How memory is managed
    - How file systems differ
    - System Architecture
- Using Word or PPT, critique the following issues with each OS:
    - Advantages and disadvantages for personal use.
    - Advantages and disadvantages for business use.
    - Advantages and disadvantages for networking use.
- Judge the process that the Practical contracts use to install each OS (Win98SE, WinNT, Win 2000, Win XP) precisely according to the "Installation Instructions" handout, on your workstation. Act as a guide and a mentor. Record in a voice journal (use PPT) the experience.
- Evaluation of the contract will be determined by:
    - Activities and products assessed by instructor (checked off)
    - The quality and accuracy of the analysis of the OS's according to the rubric
    - The quality, accuracy, and insight of the critique created according to the rubric.

The research design was a two-phase (AB) time-design series. A series of three A+ TestPrep exam simulations were randomly administered to every student during week six of the first "Six Weeks" of the second semester. The data was used as baseline for A+ TestPrep exam simulation scores. Prior to the baseline testing, the instructor designed the learning contracts based on the results of the learning style assessment. Students were assigned a differentiated learning contract based on their assessments scores in creative, practical, or analytical learning styles of the Triarchic Theory of Intelligences. The instructor decided which chapters of the textbook will be in the contract.

Within the textbook, an A+ Domain objectives chart correlates the content of each chapter to specific A+ Domain objectives. Each A+ objective relating to the chapter content were listed in the contract and connected to the performance of the contract.

The instructor decided to study four chapters that were proven through testing results, to be an area of weakness for the entire class. Chapters Twelve, Thirteen, Fourteen, and Eighteen contain in-depth and important information referencing the A+ certification test. Students practiced and learned by experiential activities, many of the essential skills and knowledge contained within these chapters.

The construction of the learning contract integrated the specific A+ objectives of each chapter. Students chose from the resources at their disposal to complete the contract and created a product to show evidence of learning and skill attainment. The second "Six Weeks" began the learning contracts and they continued for two weeks. The dates were March 6th thru March 20.

The chart below is a visual guide to the predicted time frame of the study.

Proposed Timeframe of Learning Contracts											
1st 6 weeks						2nd 6 weeks					
Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
					Pretest	Treatment	Treatment	Post-test			

In the third week of the second "Six Weeks" the students took the A+ TestPrep exam simulator, under the same environmental conditions as the pretest assessment. The instructor averaged and recorded the student's three TestPrep scores. A ***t*-test for dependent means (nonparametric measures)** indicates that a single group is being studied under two conditions. The CST1 class pretest and post-test scores were analyzed using the ***t*-test for dependent means.** This concluded the gathering of data for the research project.

Chapter 4
Results

The purpose of this action research project was to assess the change in student achievement on the A+ TestPrep exam simulator when students utilize learning contracts that use differentiation of product by learning style. This chapter reports what actually happened during the treatment

Each student was assigned a learning contract according to their learning style scores on two different abbreviated *Sternberg Triarchic Abilities Test* created by Robert Sternberg. The treatment began on Monday, March 6, 2006 and ended on Monday, March 27. The intent of the instructor was to give ample time for the completion of the contract in its entirety. As the students received their assignments, the contracts were discussed in a whole group discussion about the details involved in the contract. Many students needed scaffolding to assist them in understanding the technical tasks that were involved in the installation of the operating systems. All students had attempted and completed the tasks in earlier assignments. Those assignments, however, were isolated from other tasks and not meshed in a single objective. The contracts combined many new tasks with revisited ones to form a complex series of tasks that required the students to extrapolate, infer, experiment, and apply gained knowledge to problems encountered.

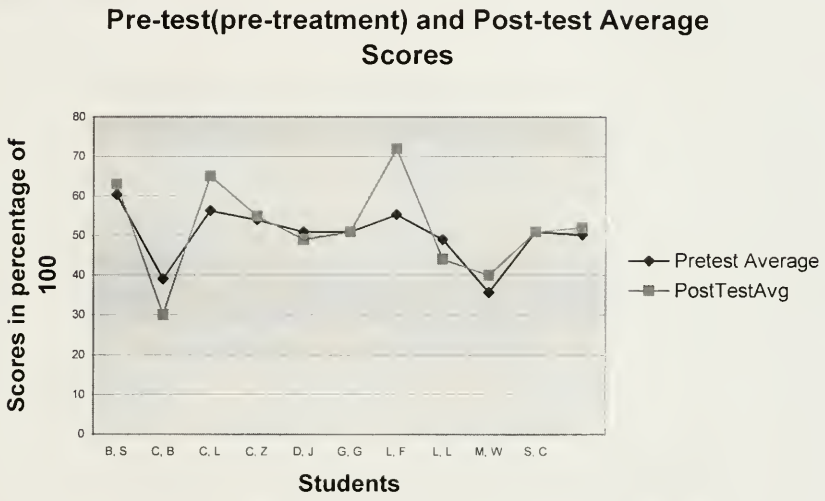
The contracts were initially planned for only ten working days of school. Unfortunately, three days were lost due to standardized testing for the junior class. The complexity and time-consuming activities and tasks required the time limit for the completion of the contracts to be extended for five more working days.

Actual Timeframe of Learning Contracts											
1st 6 weeks						2nd 6 weeks					
Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
					Pretest	Treatment	Treatment	Treatment	Post-test		

The collection of the data was achieved by the use of the testing software called A+ TestPrep Exam Simulator sold with the textbook, *A+ Guide to Managing and Maintaining Your PC, Fifth Edition, Comprehensive Edition*. The actual testing software serves as a summative assessment tool for students studying for the A+ Certification exam. It is embedded within a computer-based training program called *A+ Computer-Based Training (CBT) for Managing and Maintaining Your PC, Third Edition* by Jean Andrews. The *A+ Computer-Based Training (CBT) for Managing and Maintaining Your PC, Third Edition*, is a comprehensive study tool designed to provide complete preparation for CompTIA's 2003 A+ certification exams. This interactive learning tool allows the students to maintain a personal record of all test scores of TestPrep simulations. Hard copies of these scores were printed and retained for data collection.

The collected data was the average of three scores from each student. This data was used for the baseline and the post-treatment data. The post-test parameters were identical to the pre-test parameters. The software has two options that control testing factors. They are "time limit on test" and "show user feedback." Both of these factors were the same on the pre and posttest environments.

In the chart below, the results of the raw data before analysis are displayed.



Analysis of the raw data shows that five student's scores increased, three student's scores decreased, and two student's score did not change.

Using SPSS to analyze the raw data, the t-test for paired samples was used. The results were $t(10) = .90$, $p > .05$. The extremely small t-value shows that the amount of change is not enough to reject the null hypothesis. The change in the A+ TestPrep exam simulator scores is **not statistically significant**. With 9 df (degrees of freedom) a one-tailed test t-

value must be ≥1.833 at the .05 level of significance, in order for the results to be considered statistically significant.

Several factors may have contributed to the absence of statistical significance. These factors, or threats, are phenomenon that can jeopardize the validity or reliability of a research project. Internal and external validity threats are categorized by their interaction with the participant or data. The following threats appeared within this research study:

- Testing
  - The number of tests as a baseline
  - The exam simulator reliability was questionable
- Selection
  - The participants were not randomly selected
- Instrumentation
  - Test questions with invalid answers from software
  - Repeat (randomly) questions from software
- History
  - Only one group was used so the threat remained
  - Timeframe increased between measures thus increasing threat
  - One student studied at home outside of contract requirements
- Regression
  - A score did exhibit change that could be considered extreme
  - Scores regressed in three instances, remained the same in two and increased in five participants
  - Scores did move toward the mean

Chapter 5
Analysis and Conclusion

The analysis of the action research project data shows that learning contracts using differentiation of product by learning style does not establish a significant change in students A+ TestPrep scores. The averaged raw score of each student increased of one percentage point, from 51% to 52%. This is based on the 100% scale.

The recommendations that could be made to correct the threats encountered stem from the design of the project. Limiting the scope of the data to be measured to only one section of the A+ TestPrep domains would reduce the amount of material being taught. There are thirteen domains within the A+ TestPrep exam simulator scoring system. Each domain contributes a percentage score to the final score on the exam simulator. By narrowing the focus of the contract to only one domain, the quantity of produced material from the contract would decrease, but the quality would increase. The student would have an opportunity to internalize less data and to produce work at a higher degree of accuracy.

A second recommendation would involve purchasing more accurate software to test the student's readiness to take the actual A+ exam. Several questions had the wrong answer marked by the software. The students selected the correct answer, only to be scored wrong by the software. Whenever this situation was encountered, the test score would have to be manually adjusted jointly by the student and instructor.

Even though the research project was found not to be statistically significant, various positives evolved from the project. The products produced were rich, accurate

with details that are normally difficult to express in multiple-choice assessments, and highly authentic to the students individual skills.

Student frustration from having to plan, problem-solve, utilize resources, and supervise their time-on-task was observed as above normal for all students. The instructor advised where data could be found but refused to relinquish the data itself.

The level of student engagement was particularly elevated. The interest in completing the contract stemmed from the results requested by the contract. Built into the analytical and practical contracts was the requirement of networking all computers in a peer-to-peer configuration and sharing data across the network in real-time. The requirement was later added to the creative contracts. As a motivational incentive, an educational game was approved to be the testing software for networking ability. An incredible amount of attention to detail was displayed from many students in how to implement the skills of cable creation, IP protocol assignment, and hub architecture design.

In the future, the use of differentiated contracts will be supported by the recommendations offered in this chapter. Differentiating product by learning style was effective in various areas of student learning. It will be used again, due to student response and quality of work produced within the contracts. There will be an attempt to measure student motivation when assigned contracts according to learning style, possibly using a Likert scale survey. Student motivation was too high to not measure in the next project. Differentiation allows instructors to teach to all levels of learners in methods that may promote learning, interest, and engagement. Keeping the focus of future learning contracts narrow or increasing the timeline to complete the contract are key to the success

of forthcoming research. More exploration of methods that improve student achievement on the A+ exam is warranted and necessary. Enabling students with technical skills to obtain high paying jobs or enlightening them to their hidden talents not yet known are the prime directives for this class. Action research will continue to help accomplish these directives.

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